

Barrio Logan Modeling Analysis : Estimating Ambient Exposure to Toxic Air Contaminants in California Neighborhoods with Air Quality Models

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Air Toxics Exposure Assessment Workshop
San Francisco, CA, June 25-27, 2002

Modeling Overview for Barrio Logan

- † Conceptual Modeling Protocol
- † Local emissions near Barrio Logan
- † Local scale modeling results at Barrio Logan
- † Inhalation Risk at Barrio Logan
- † Model Evaluation
- † Uncertainty analysis



Modeling Protocol

- † recommend a method to perform neighborhood assessments
- † develop and evaluate methodologies to estimate annual average concentrations of various pollutants released from multiple sources at the neighborhood scale

Modeling working group includes more than 40 participants from government agencies, universities, industry, and environmental groups. We share information, discuss the modeling approach and technical details at group meetings. The modeling protocol has undergone a peer review process.



Size of Modeling Domain

- † Micro-scale (Neighborhood scale) modeling - receptors located near emission sources, i.e., meters to few kilometers from the sources
- † Regional scale modeling - source and receptor distances of several kilometers, to hundreds of kilometers, to the size of air basins



Air Toxic Pollutants To Be Modeled

† Micro-scale modeling - more than 100 pollutants, including:

Acetaldehyde, Acrolein, Acrylonitrile, Arsenic, Benzene, Beryllium, 1,3-Butadiene, Cadmium, Chloroform, Hexavalent Chromium, Ethylene Dibromide, Dioxin, Diesel PM, Formaldehyde, Hydrazine, Lead, Manganese, Methylene Chloride, Mercury, Nickel, (PCBs), Perchloroethylene, Trichloroethylene, Vinyl Chloride

† Regional modeling - 30 pollutants:

Acetaldehyde, Acrolein, Arsenic, Benzene, Beryllium, 1,3-Butadiene, Cadmium, Carbon Tetrachloride, Chloroform, Diesel PM, Ethylene Dichloride, Ethylene Oxide, Formaldehyde, Hexavalent Chromium, Iron, Lead, Manganese, Mercury, Methylene Chloride, MTBE, Nickel, o-Dichlorobenzene, p-Dichlorobenzene, Perchloroethylene, Styrene, Toluene, Trichloroethylene, Vinyl Chloride, Xylenes, Zinc



Micro-scale Models to Estimate Annual Concentrations

† Traditional Models

ISCST3 - U.S. EPA regulatory model

CALINE - U.S. EPA approved model for line sources

† Advanced Models

AERMOD - recommended as replacement for ISCST3

CALPUFF- recommended model for complex terrain and for long-range transport

† New and Emerging Models

Lagrangian particle dispersion model - state-of-the-science short-range model that estimates concentrations at scales of meters to tens of meters from a source



Regional Models To Estimate Annual Concentrations

† Traditional Models

UAM (Urban Airshed Model) - used for air quality planning

† Advanced Models

Models-3 - state-of-science model developed by U.S. EPA



Recommendations From Study

- † Identify which micro-scale and regional models are best suited for assessing neighborhood impacts
- † Develop recommendations and guidelines for assessing the cumulative impacts posed by air pollutants at the neighborhood-scale
- † Share modeling results and recommendations with U.S. EPA and other interested groups

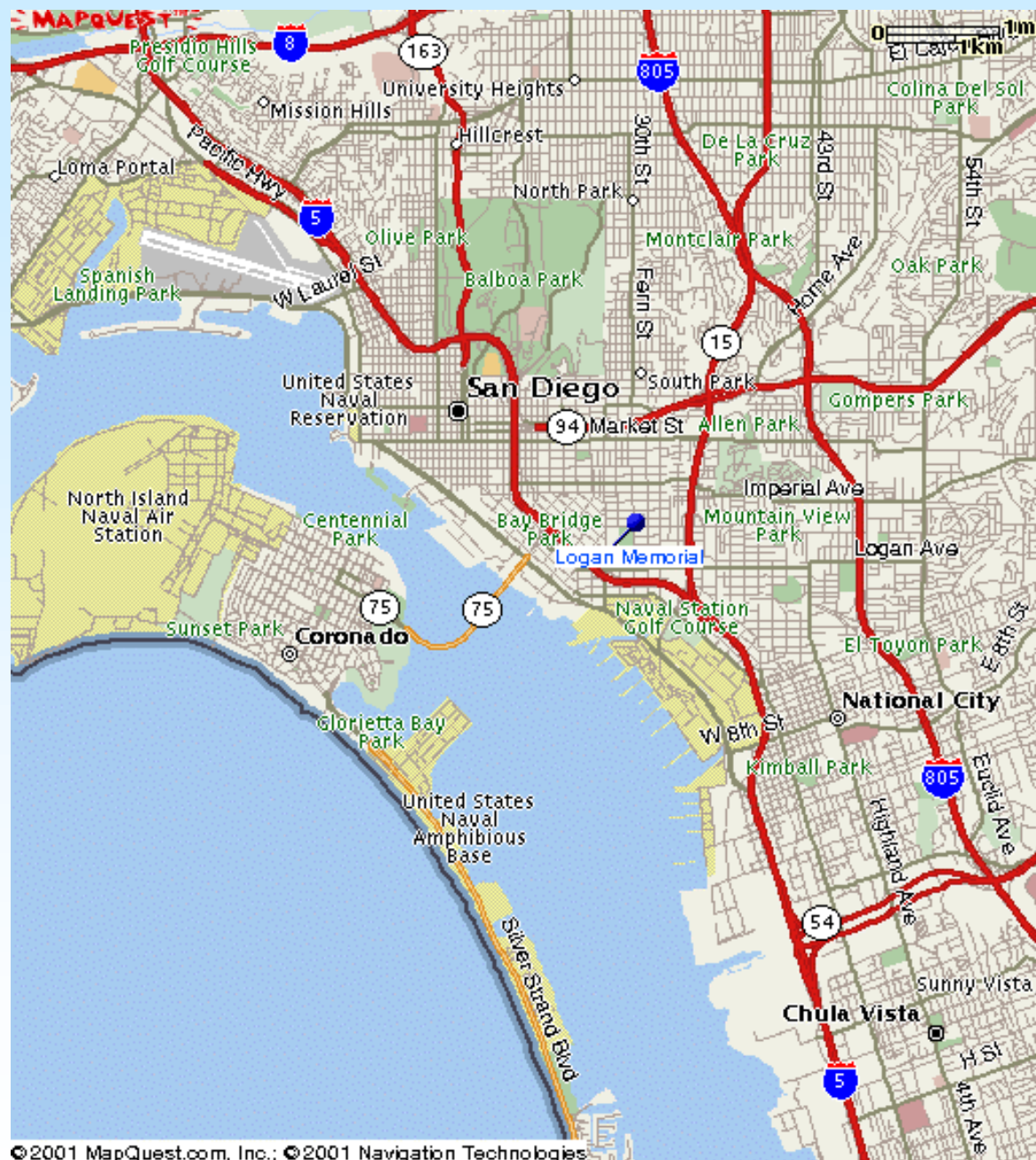


Modeling Overview for Barrio Logan

- † Local emissions only
 - Cars & Trucks - CALINE
 - Facilities - ISCST3, AERMOD, CALPUFF
- † Primary emissions
 - no chemical reaction
 - no deposition
- † Results are predicted with
 - ISCST3 and CALINE
- † Inhalation risk is based on predicted concentrations from local emissions



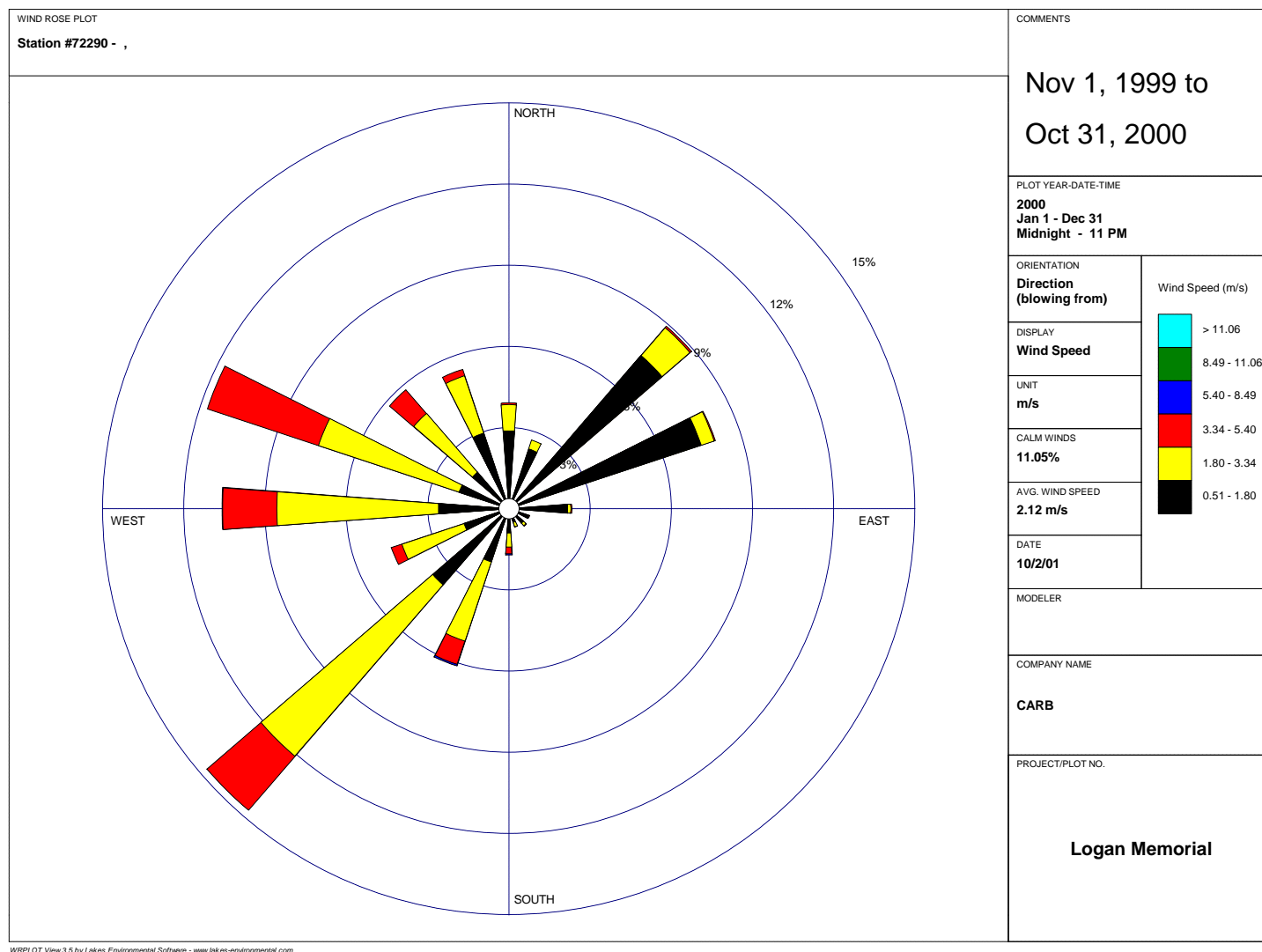
- Lindbergh Field
- North Island
- Shipping Lane
- Logan Memorial



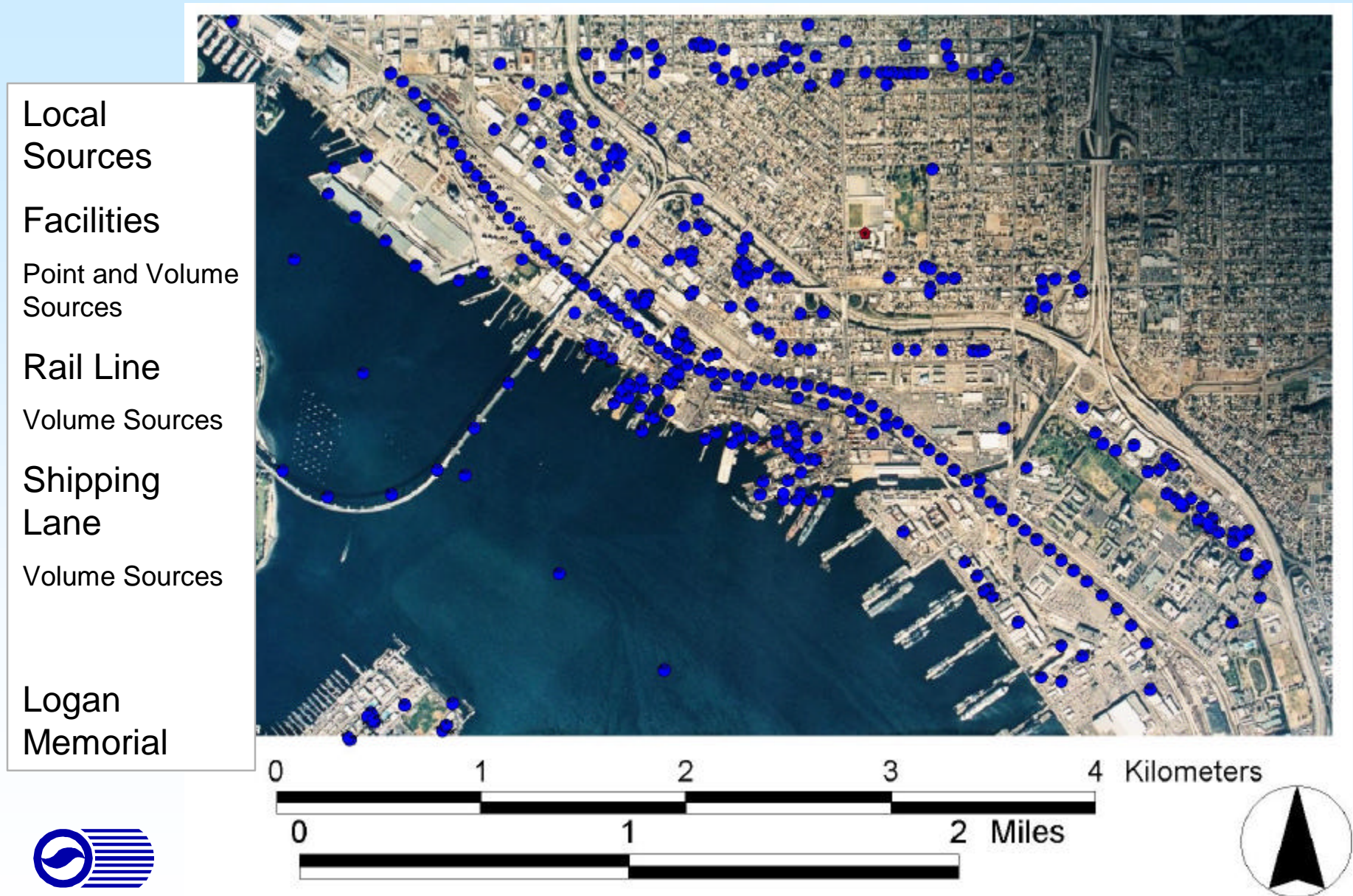
Logan Memorial Wind Rose

Sea
Breeze
(predominately
daytime)

Land
Breeze
(predominately
nighttime)

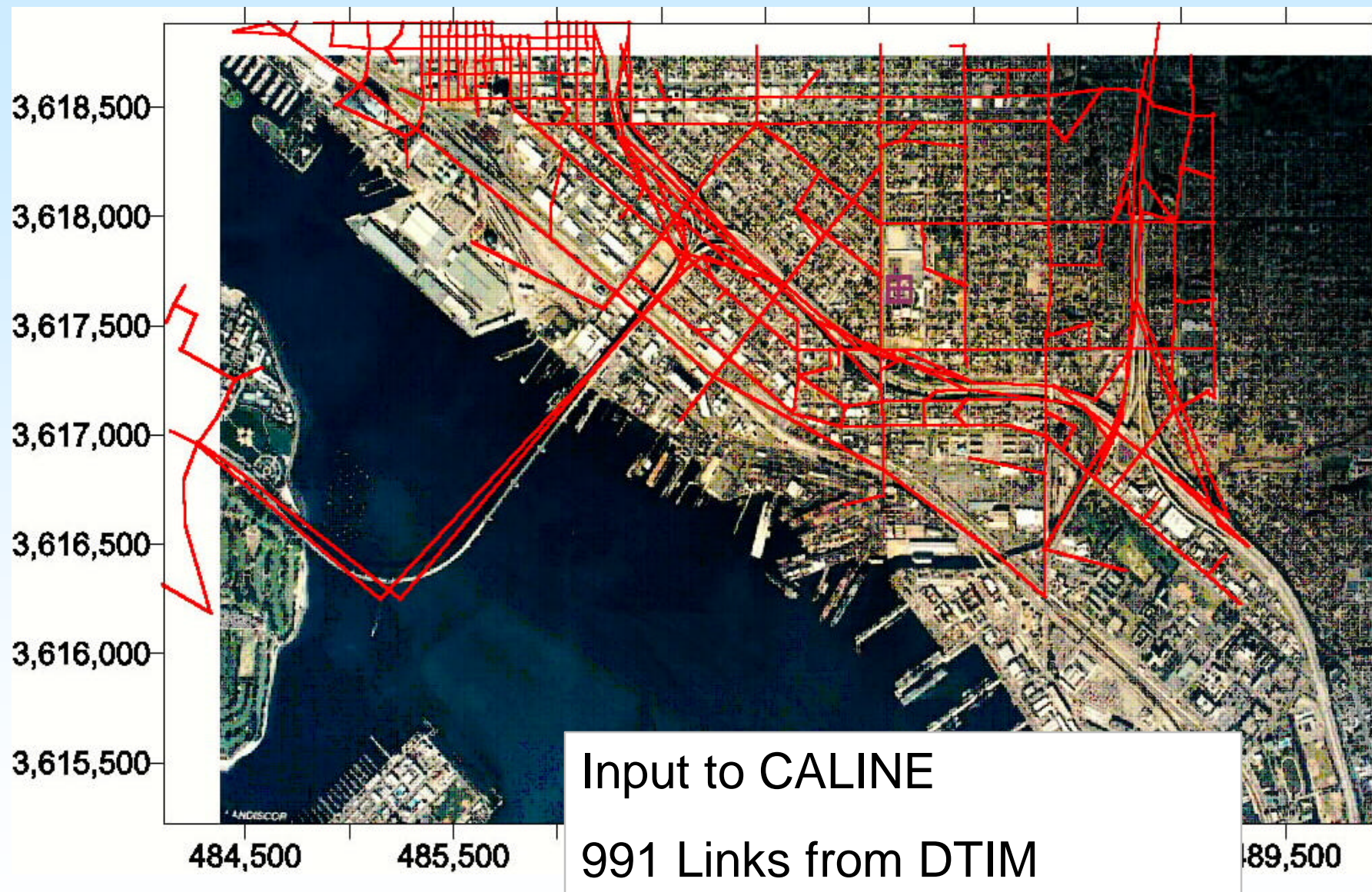


Aerial View of Barrio Logan

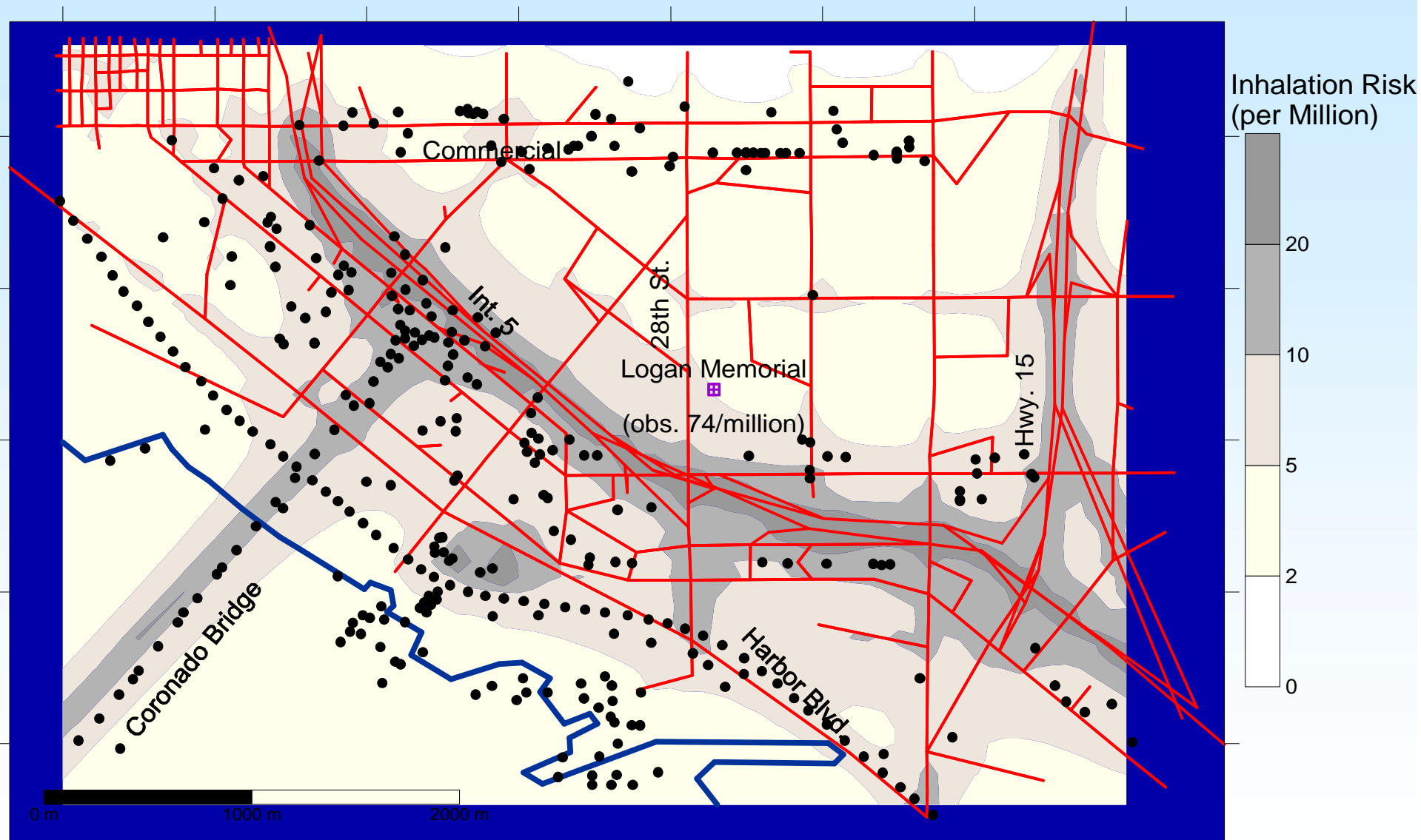


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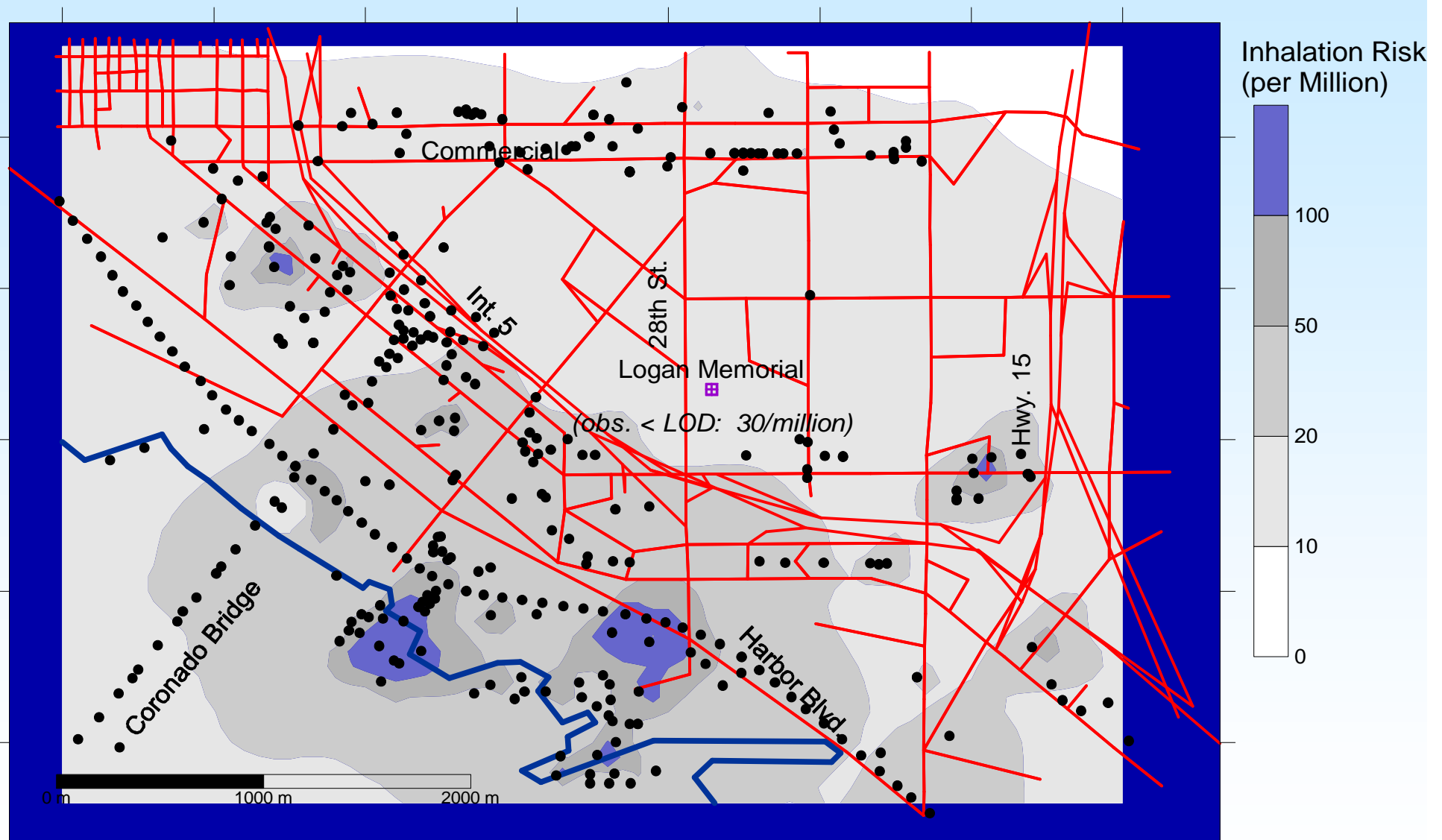
Motor Vehicle Segments – Road Links



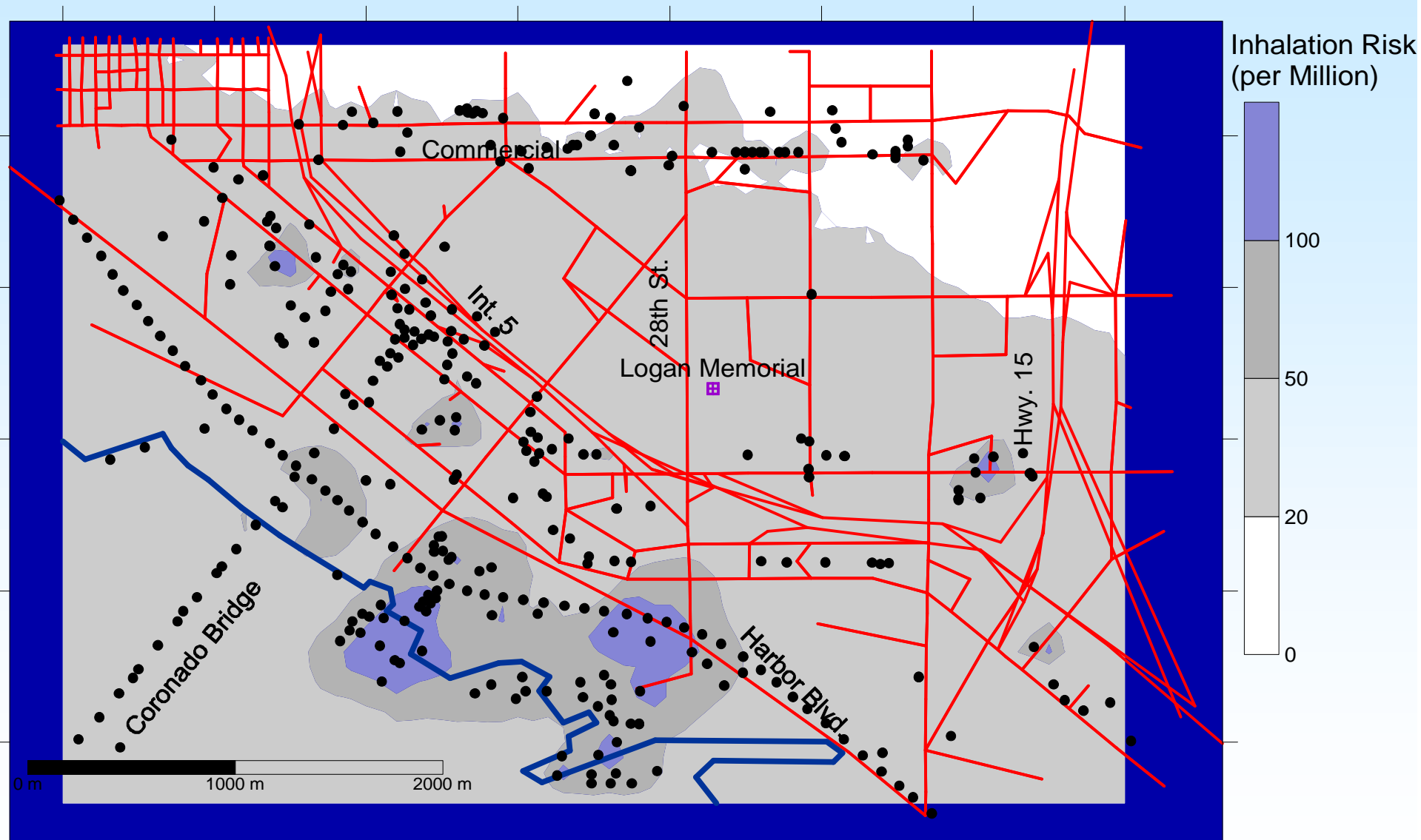
Risk from Benzene (local emissions)



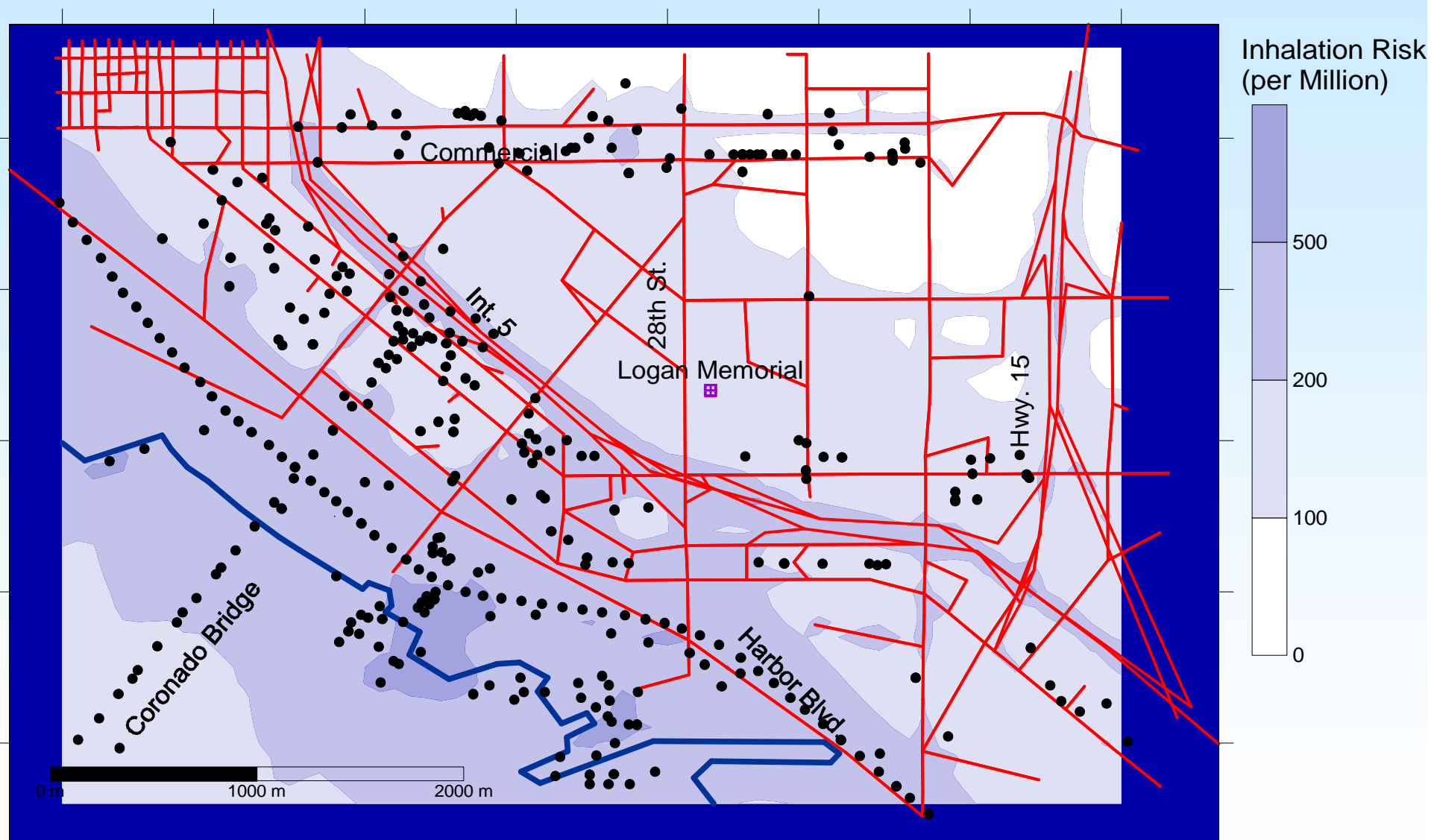
Risk from Cr(VI) (local emissions)



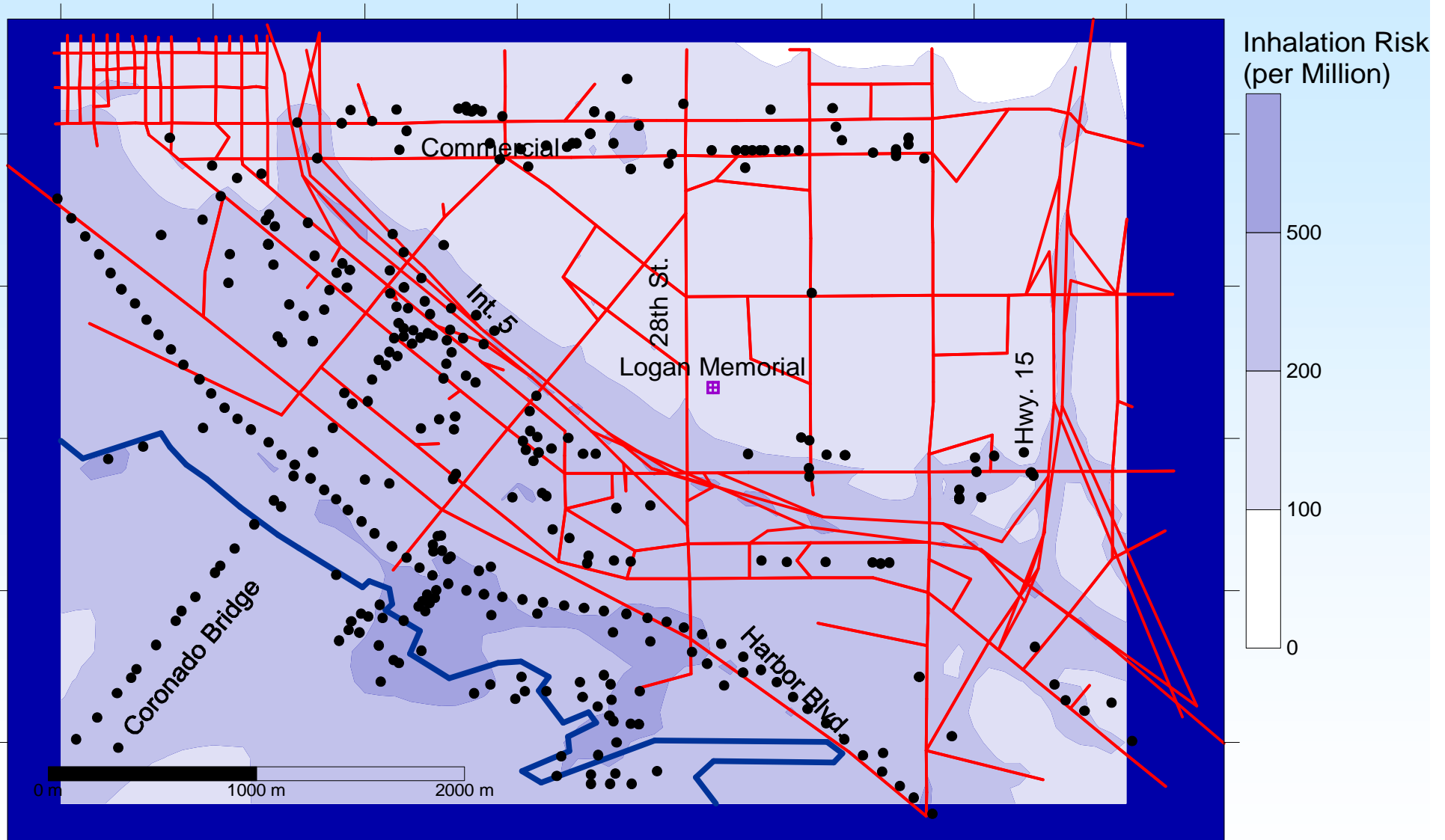
Risk – all sources (w/o Diesel PM)



Risk – Diesel PM



Risk Summary – All Pollutants

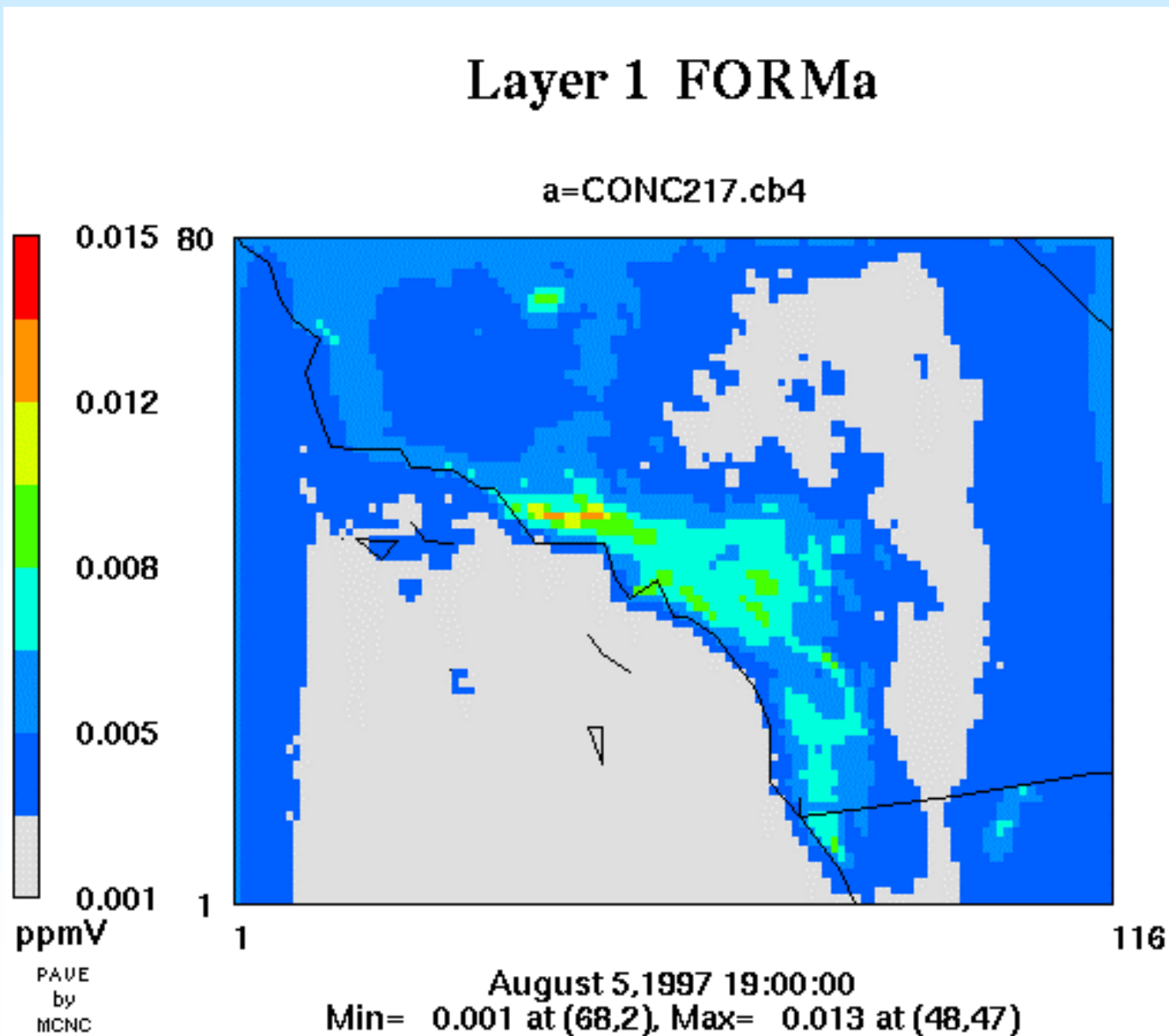


Further Analysis

- † Simulations with
AERMOD
CALPUFF
- † Evaluation of the tracer studies and
model performance
- † Adjust for background concentrations
using results from regional modeling



Regional Modeling: CMAQ results



Regional Modeling: CMAQ

Formaldehyde Concentrations [$\mu\text{g}/\text{m}^3$]

- **CMAQ (1 day 08/05/97)** **2 - 10 (San Diego)**
 2 - 18 (Los Angeles)
- **EPA OZIPR (summer)** **8 - 19 (Los Angeles)**
- **EPA OZIPR (ann. avg.)** **14.5 (Los Angeles)**
 1.1 - primary, 13.4 - secondary
- **CALINE (annual avg.)** **0.1- 0.2 (Barrio Logan) - primary**
- **ISCST3 (annual avg.)** **< 1 (Barrio Logan) - primary**
- **Observed (ann. avg., 97)** **2.9 (San Diego, Chula Vista)**
 4.5 (Los Angeles, N. Long Beach)



Model Performance Evaluation

A scientific process to ensure models are working properly and predict reliable concentrations

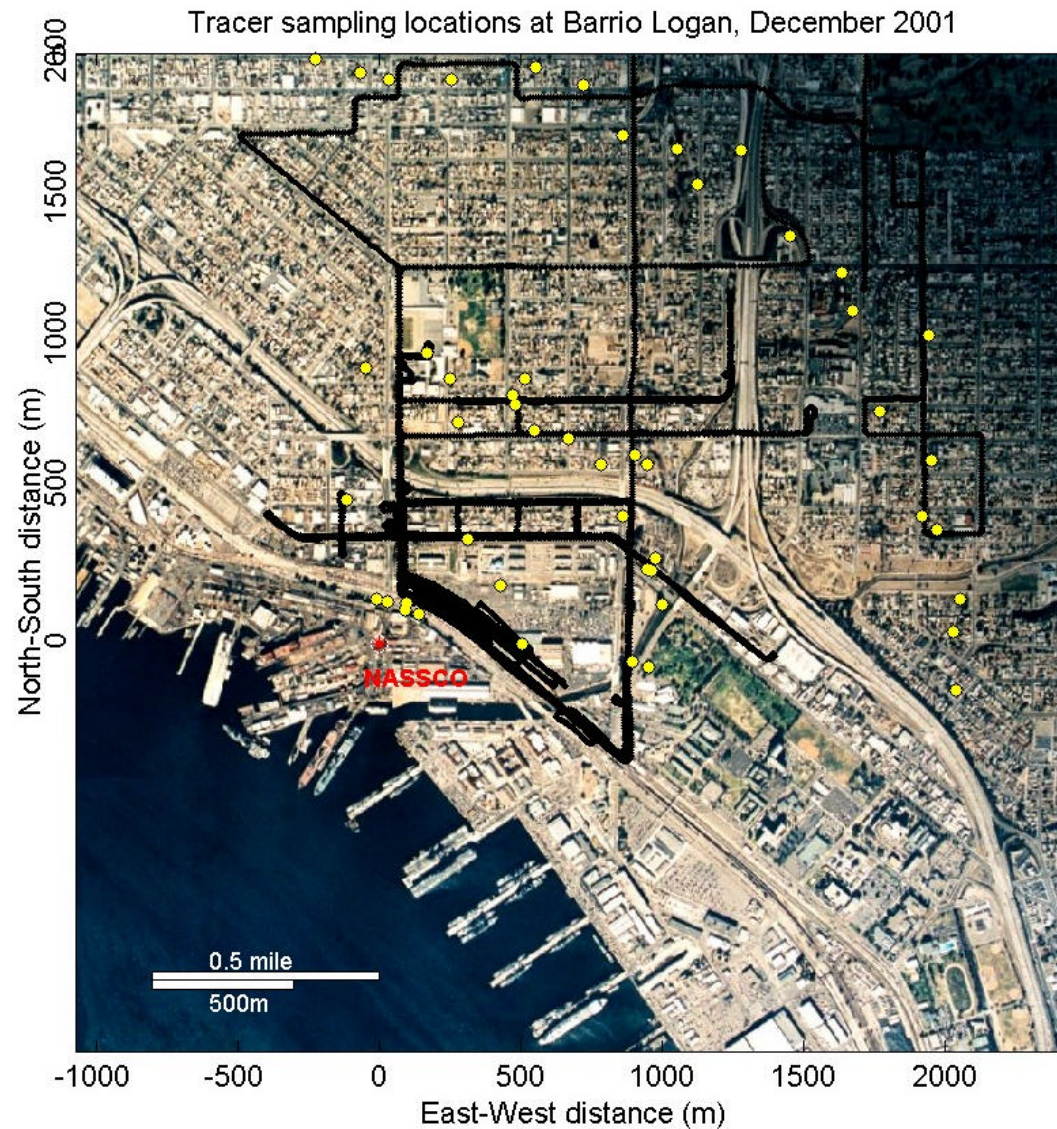


Tracer Experiment at Barrio Logan

- † Tracer Experiment conducted in August and December of 2001
- † Hourly SF6 concentrations sampled at 50 sites
- † Tracer released at NASSCO during daytime from 10 a.m. to 10 p.m.
- † Mobile van sampled continuously to measure crosswind SF6 concentrations
- † Mini-sodar to measure vertical winds up to 200m at 5m resolution
- † Six sonic anemometers to measure surface level winds and turbulence



Locations of samplers and mobile van measurements



Mobile Sampler



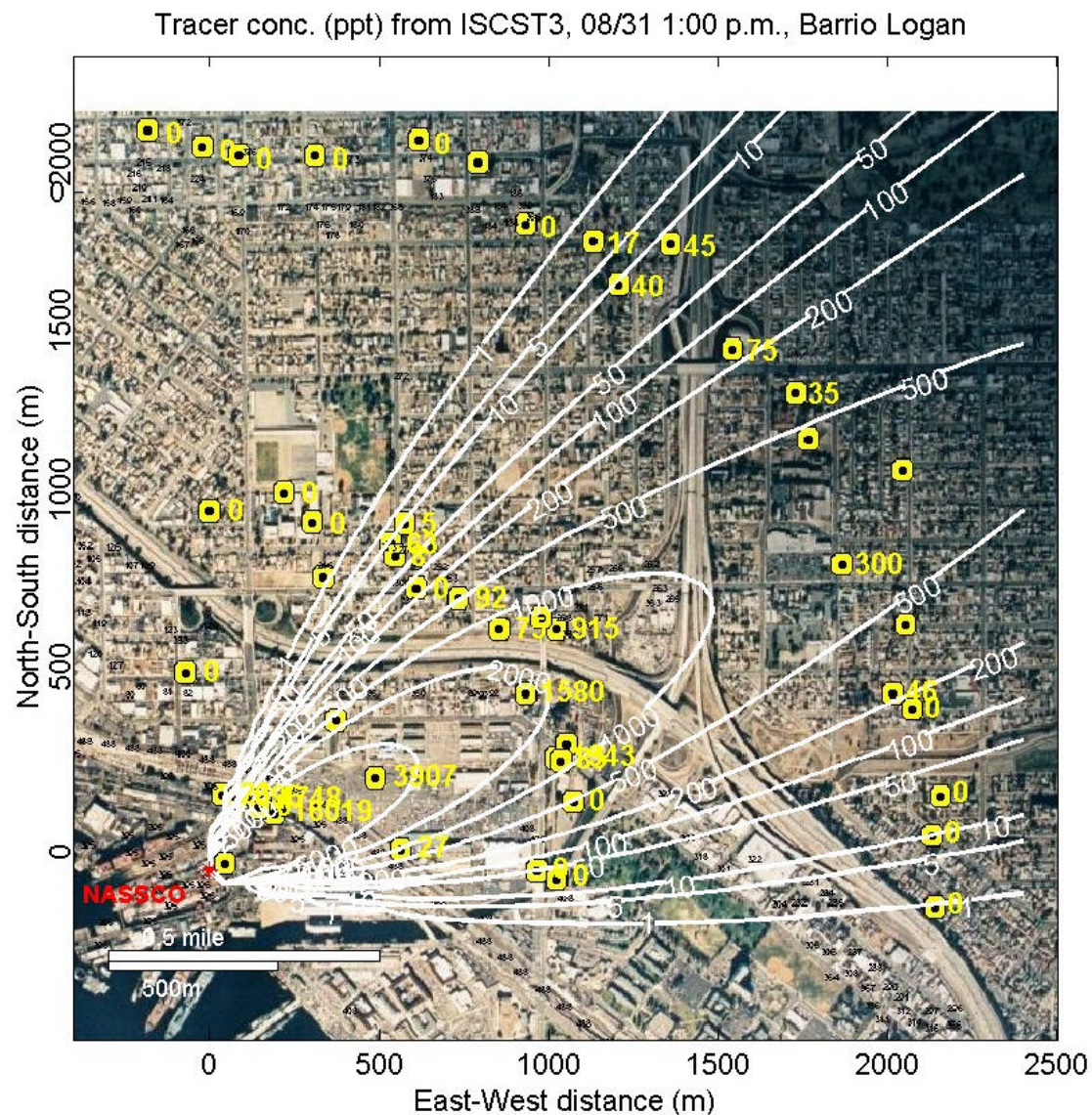
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Sampler (Bag), Residence



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Model evaluation - ISCST3



Model evaluation - future work

- † Conduct another SF6 tracer experiment and toxics sampling in Los Angeles - Wilmington (summer 2002 and 2003)**
- † Evaluate models using new database**
- † Identify which models and model options are best suited for assessing neighborhood impacts**
- † Share modeling results and recommendations with U.S. EPA and other interested groups**



Uncertainty Analysis

Objectives

- Develop a comprehensive methodology to assess uncertainty in annual average concentration estimates
- Identify major sources of uncertainty and target for refinement



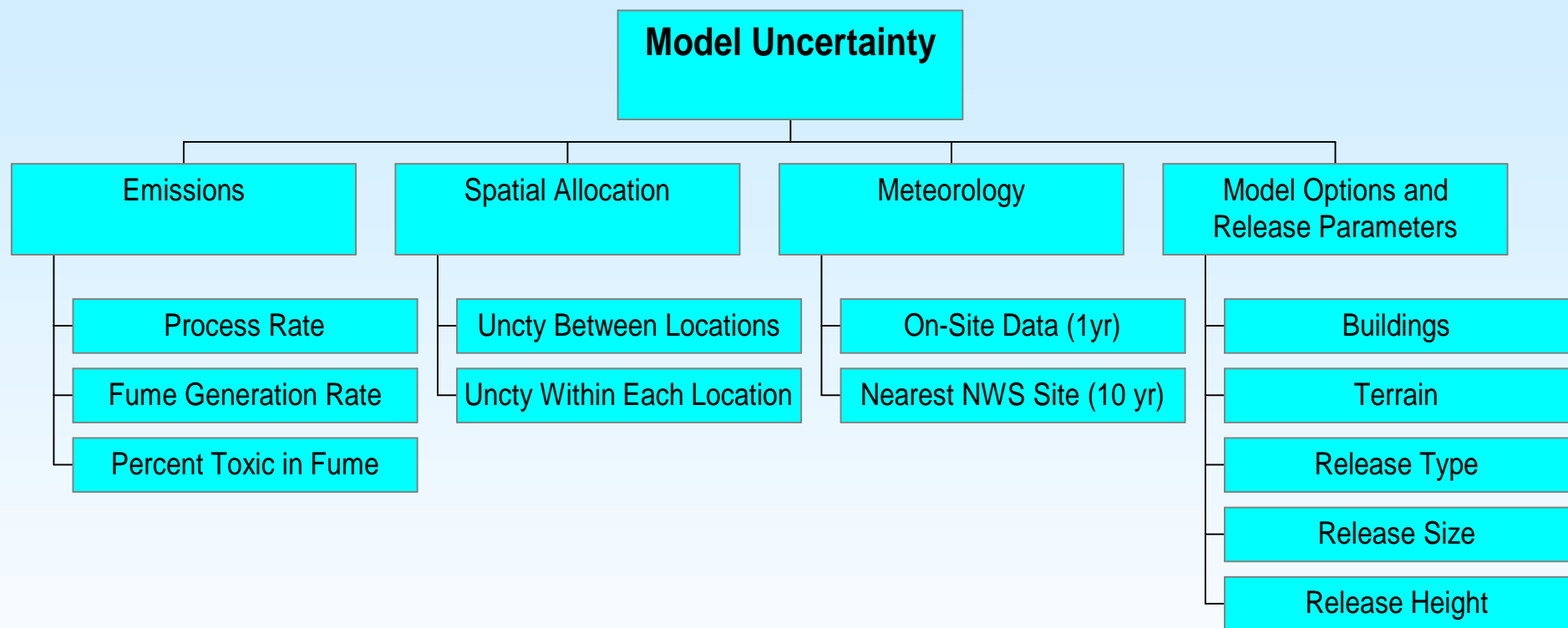
Uncertainty Analysis - Approach

To demonstrate - Single facility, one pollutant

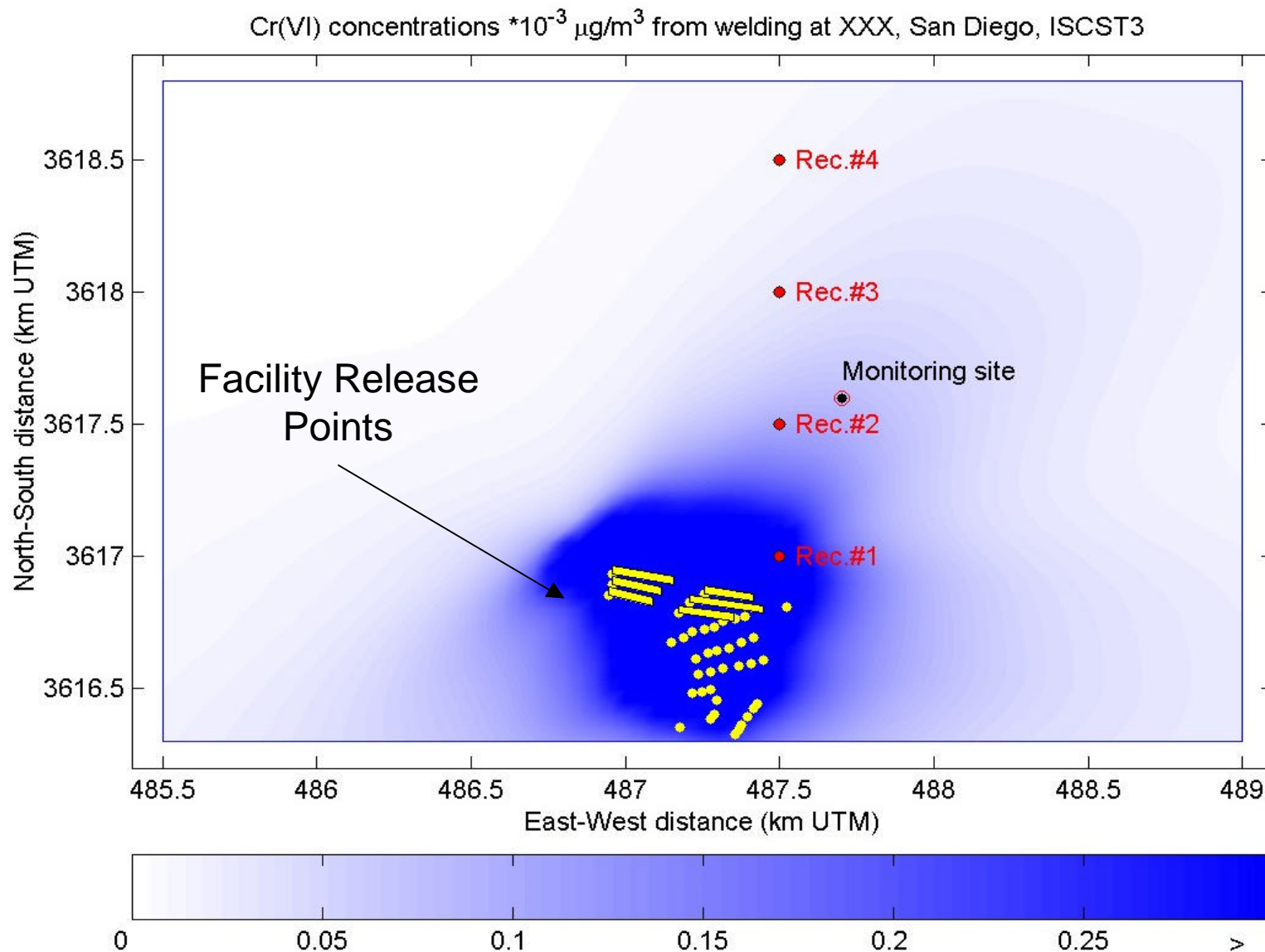
- Welding operations at shipbuilding / repair facility
- Break model into components, using available data to represent model inputs as distributions
- Apply dispersion model
- Use statistical sampling from distributions to estimate range of possible model results



Uncertainty Analysis - Approach



Uncertainty Analysis - Receptors



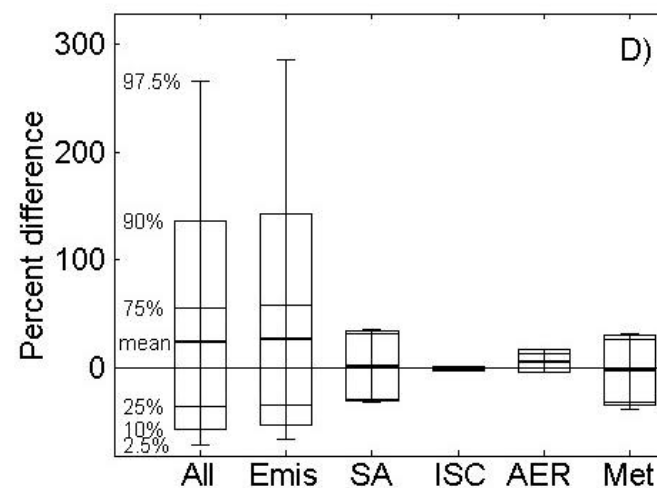
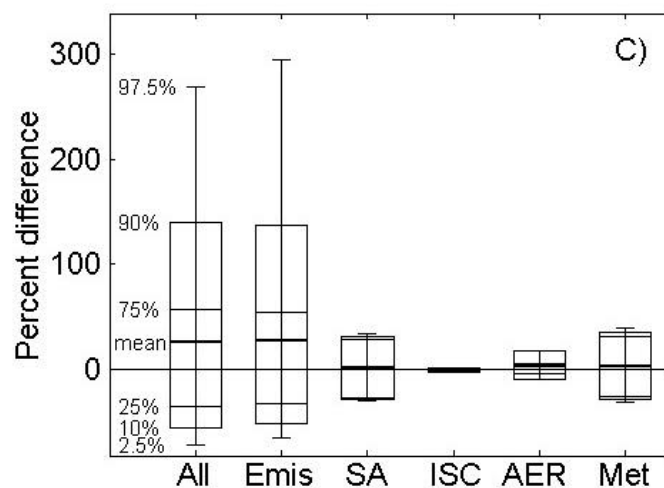
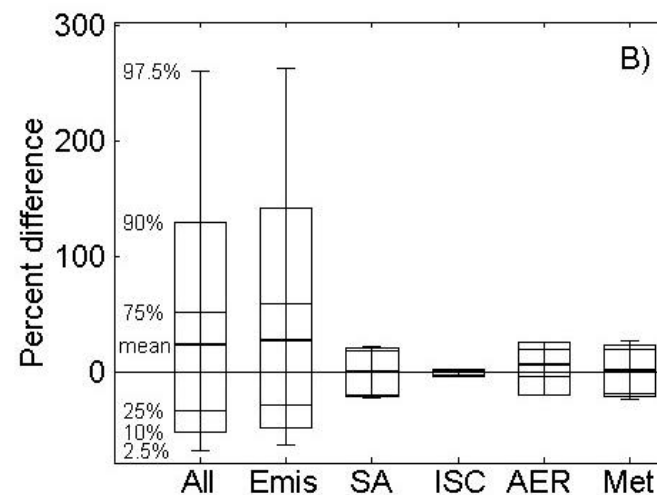
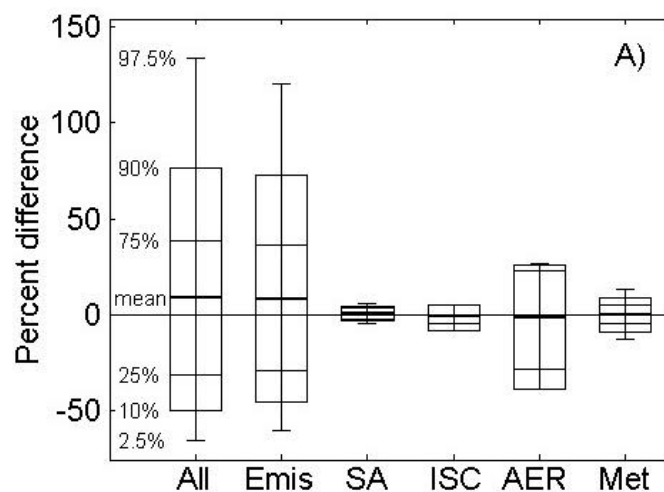
Note: concentrations based on median emission rates

Uncertainty Analysis - Model Propagation

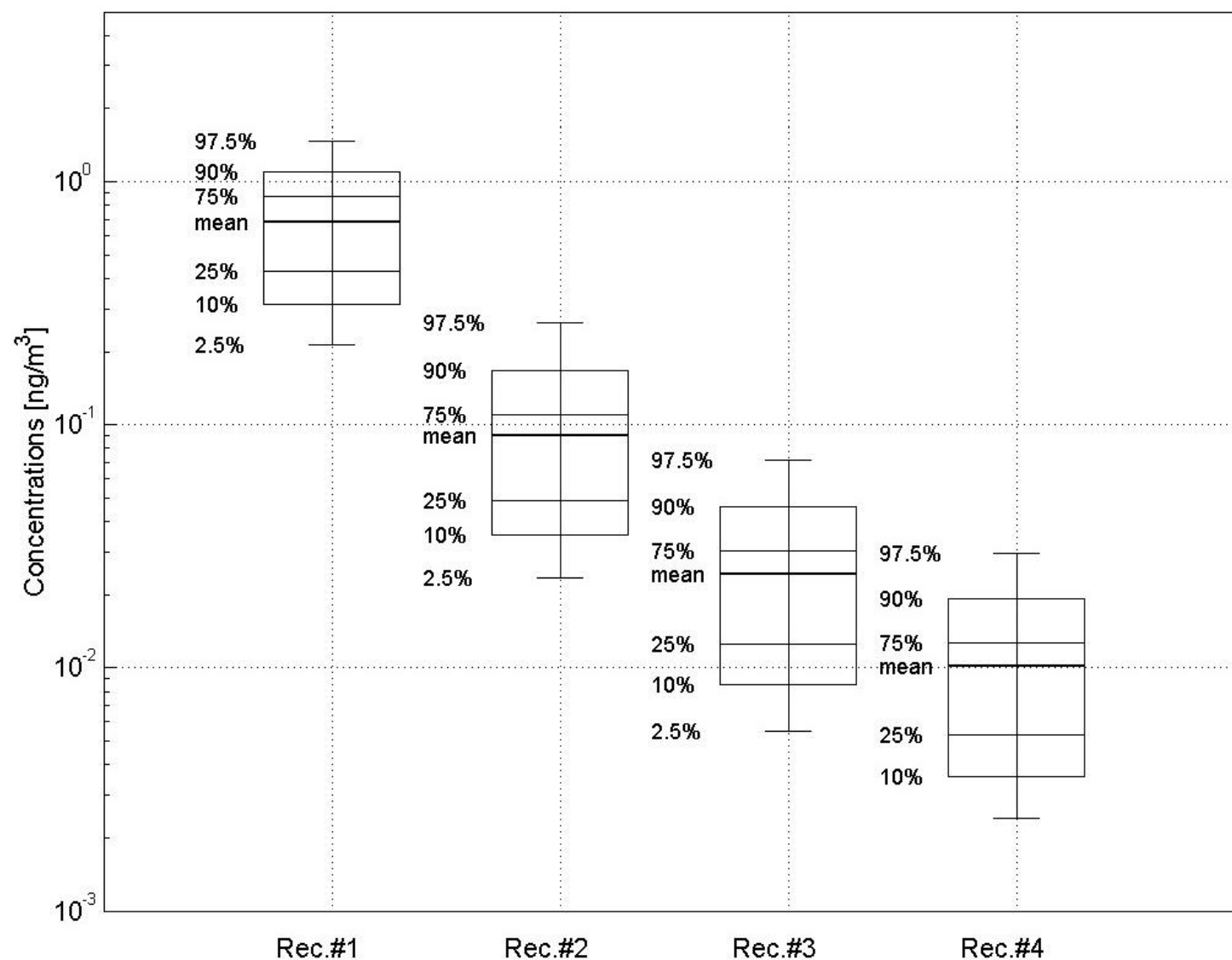
- Monte Carlo Simulation: EM x SA x MET x MO
 - Statistical sampling to estimate range of outcomes at each receptor (n=1000)
 - Apply simple percentile confidence intervals
 - Health risk estimates for context, URF 0.15
- Results

Receptor	Measure	Median	Confidence Interval		
			2.50%	-	97.50%
1	Concentration (ng/m3) Estimated Cancer Risk	0.70 100	0.30 40	- -	1.50 220
2	Concentration (ng/m3) Estimated Cancer Risk	0.10 13	0.03 5	- -	0.30 50
3	Concentration (ng/m3) Estimated Cancer Risk	0.03 4	0.01 1	- -	0.08 12
4	Concentration (ng/m3) Estimated Cancer Risk	0.01 2	0.004 1	- -	0.03 5

Uncertainty Analysis - Results



Uncertainty Analysis - Results



Conclusions

- Factor of 3 uncertainty in this case.
- Emissions are dominant source of uncertainty, but model is sensitive to all factors.
 - Emissions inventory and meteorological databases must have sufficient level of details to support modeling scale.
- Absolute magnitude of uncertainty greatest in the near field, decreases with distance.
- AERMOD capable of providing greater range of results than ISCST3 because is a more complex model with many model options
 - Therefore modeling guidance for AERMOD is important

